

Qualitative Comparison of IGRA and ESRL Radiosonde Archived Databases

John Walker

ESSSA / Tuskegee University

*Natural Environments Day of Launch Working Group
March 19, 2014*

Synopsis

- Multiple databases of atmospheric profile information are freely available to individuals and groups such as the Natural Environments group.
- Two of the primary database archives provided by NOAA that are most frequently used are those from the Earth Science Research Laboratory (ESRL) and the Integrated Global Radiosonde Archive (IGRA).
- Inquiries have been made as to why one database is used as opposed to the other, yet to the best of knowledge, no formal comparison has been performed.
- The goal of this study is to provide a qualitative comparison of the ESRL and IGRA radiosonde databases.

Synopsis

- For part of this analyses, 14 upper air observation sites were selected. These sites all have the common attribute of having been used or are planned for use in the development of Range Reference Atmospheres (RRAs) in support of NASA's and DOD's current and future goals.

RRA Upper Air Sites	
(CCAFS) Cape Canaveral Air Force Station, FL	(EGL) Eglin Air Force Base , FL
(EAFB) Edwards Air Force Base, CA	(YSD) Yuma Proving Ground, AZ
(VAFB) Vandenberg Air Force Base, CA	(DUG) Dugway Proving Ground, UT
(WSMR) White Sands Missile Range, NM	(PTU) Point Magu Naval Air Station, CA
(WFF) Wallops Flight Facility, VA	(CHL) China Lake Naval Air Station, CA
(THU) Thule, Greenland	(WAK) Wake Island, Pacific Ocean
(KOD) Kodiak Island, AK	(KMR) Kwajalein Missile Range, Marshall Islands

Synopsis

- The ESRL / IGRA comparison study was performed using a variety of metrics:
 - Availability of Data (How easy is it to acquire?)
 - Availability and Accuracy of Documentation
 - Data Format and Content
 - Range of Data Periods (For specific sites)
 - Inventory of All Data Observations (For specific sites)
 - Methods of Quality Assurance
- Plans for future work will be discussed

Synopsis

- Note:

The purpose of this presentation is to provide findings from this comparison study and to incite fruitful discussion

Given that, and the fact that this study is on-going, no “clear winner” will be announced at the conclusion of this study.

Availability of Data

- ESRL Online Data Access:
 - <http://www.esrl.noaa.gov/raobs/>
 - Data records were **only available for 13 out of the 14 upper air sites** for which data was requested (Missing “WAK” / 91245).
 - At the time that this analysis began online access to ESRL data was only available from 1990 through the present. However, as of January 2014, online access to data extends back to 1946.
- IGRA Online Data Access:
 - <http://www.ncdc.noaa.gov/oa/climate/igra/>
 - Data records were available for all 14 upper air sites for which data was requested.
 - Online access to data includes the entire periods of record.

Availability and Accuracy of Documentation

- Both databases have a sufficient amount of documentation
 - Online web-based format
 - Peer reviewed journal articles
- Documentation about the order and structure of the data files for each database is detailed and clear.
- Several inaccuracies were discovered in the online ESRL documentation
 - ESRL documentation states that, as of 2007, their database encompasses all of the IGRA profiles in addition to previously existing ESRL data. A review and comparison of available data from ESRL and IGRA shows this statement to be false.
 - Deficiencies in inventory documentation
 - Deficiencies in station history documentation

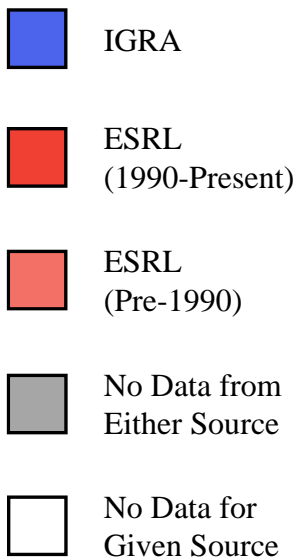
Data Format and Content

	IGRA	ESRL
Included Data Fields	Height, Pressure, Temperature, Humidity, Wind Speed/Direction	Height, Pressure, Temperature, Humidity, Wind Speed/Direction
Wind Speed Units	“m/s”	“m/s” –or– “knots”
Humidity	Dew Point Depression	Dew Point Temperature
Data Above 100mb ?	YES	NO
Surface Level Obs ?	YES	YES
Additional Wind Level Data ?	YES	YES
Report Time ?	YES	YES
Launch Release Time ?	YES	YES

Range of Data Periods

- A combination of documented and self-checked inventory analyses allowed for a comparison of the number of years over which data is available in the ESRL and IGRA databases for each of the 14 selected sites.
- At the time of this analysis, because data from ESRL was not readily available from pre-1990, ESRL documentation was used to try to piece together the ranges of ESRL data through 1990. All IGRA data ranges were manually confirmed for their entire periods of record.
- The earliest year for which data was advertised as being available for any of these sites was 1942 (ESRL database; Kodiak Island, AK). As a result, all sites were queried for the presence of data between 1942 - 2013.

Legend



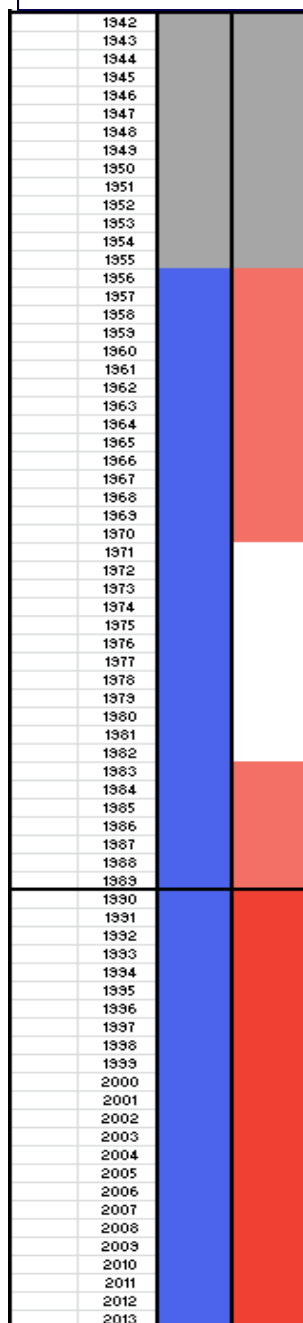
Left Column:

IGRA Data

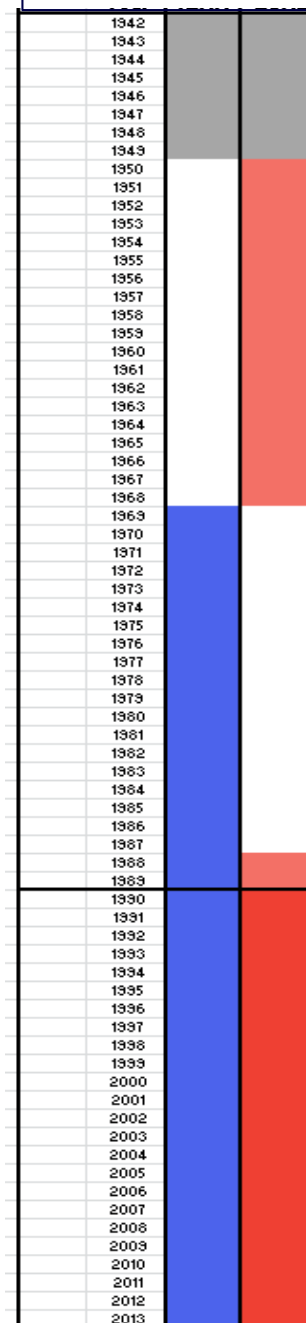
Right Column:

ESRL Data

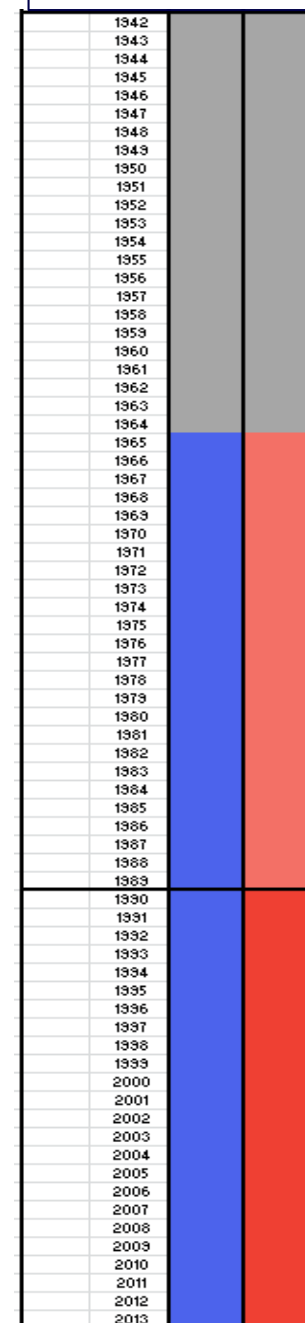
CCAFS



EAFB



VAFB

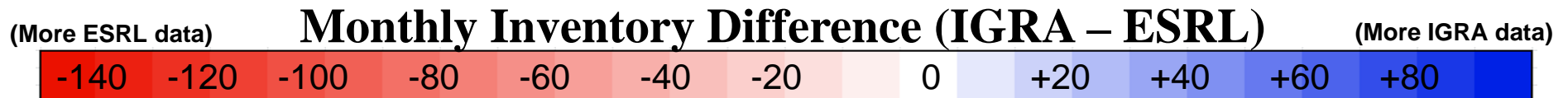


Inventory of All Data Observations

- A monthly inventory of all upper air profiles was tallied from both ESRL and IGRA databases for all 14 RRA sites, using available data from each of the respective online archives.
- Because 1990 was the oldest year for which ESRL data could be acquired at the time of this analysis, that was the limiting factor. So, the inventory for both archives begins in January of 1990 and extends through the end of October of 2013, shortly before the analysis began.
- In this analysis, the inventories of ESRL and IGRA data are completely independent of one another and do not take into account whether or not the tallied profiles are shared between the two archives or are unique.

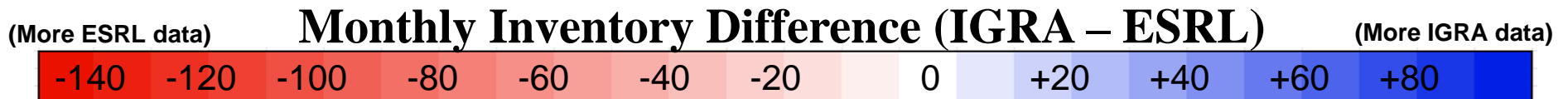
Inventory of All Data Observations

CCAFS 74794													
Year	Total Yearly Diffs:	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
1990	712	58	61	57	54	61	65	61	69	63	58	64	41
1991	565	40	36	61	58	61	60	73	78	60	23	9	6
1992	86	7	8	6	0	-2	6	11	11	16	8	9	6
1993	66	10	8	8	21	12	20	18	6	29	-3	-26	-37
1994	-35	-3	3	-2	-4	-3	-2	-5	-3	-5	-2	-4	-5
1995	-7	-12	-1	-4	-3	2	1	3	3	0	1	3	0
1996	-43	-5	-3	-2	-4	-6	-4	0	-8	-2	-3	0	-6
1997	-26	-5	-4	0	-5	0	-6	1	-1	-3	-1	-1	-1
1998	-12	1	-1	0	0	0	0	0	-2	-1	0	-2	-7
1999	-25	1	-2	-1	-1	-2	-1	2	-3	-2	-1	-3	-12
2000	-1	0	0	0	1	0	0	-1	0	-1	0	0	0
2001	-5	0	0	0	-3	0	0	0	-1	0	0	-1	0
2002	-47	-4	-6	-5	-3	-7	-6	-2	-1	-5	-1	-7	0
2003	-2	0	0	-1	0	0	0	0	0	0	0	-1	0
2004	-3	0	0	0	0	0	-4	0	0	1	0	0	0
2005	3	-2	0	1	1	1	0	0	1	0	0	1	0
2006	-1	0	0	0	0	0	0	-1	0	0	0	0	0
2007	0	0	0	0	0	0	0	0	0	0	0	0	0
2008	-32	-1	0	0	-1	0	-2	0	0	0	0	0	-28
2009	0	0	0	0	0	1	0	-1	0	0	0	0	0
2010	-35	0	0	0	0	0	0	0	0	0	0	-1	-34
2011	16	0	0	0	1	0	0	0	7	5	4	-1	0
2012	-13	1	0	-1	1	0	0	2	0	3	-1	0	-18
2013*	0	0	1	0	0	2	0	0	0	-3	0	0	0
Summed Diffs:	1161	86	100	117	113	120	127	161	156	155	82	39	-95



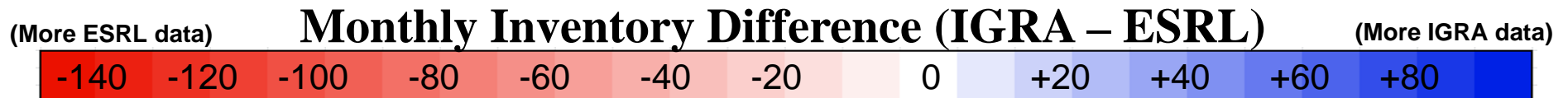
Inventory of All Data Observations

EAFB 72381													
Year	Total Yearly Diffs:	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
1990	-4	6	-7	1	2	-7	-5	0	0	0	3	-5	8
1991	-14	4	0	0	-5	-12	0	-4	-7	-3	1	4	8
1992	24	9	7	7	-1	2	-9	-5	1	1	6	1	5
1993	-361	-41	-33	-44	-65	-62	-70	-5	2	6	10	-29	-30
1994	-165	-6	-16	-17	-16	-1	-3	-20	-13	-21	-11	-17	-24
1995	-164	-33	-35	-35	-8	-4	-5	-5	-10	1	0	-21	-9
1996	-129	-14	-21	-25	-7	-5	-5	-7	-6	-5	-1	-24	-9
1997	-81	-17	-15	-2	-5	-5	-2	-11	-7	-4	-5	-5	-3
1998	-13	0	-1	-1	0	0	-1	-1	-6	0	1	-2	-2
1999	-102	-1	-5	-4	0	0	-1	-1	0	-1	-17	-32	-40
2000	-19	-2	0	0	0	0	0	-3	-5	-3	-2	-3	-1
2001	-31	1	-1	0	-5	-4	-1	-3	-5	-4	-3	-2	-4
2002	-17	-1	0	-7	-1	-3	-2	0	0	-1	0	-1	-1
2003	0	0	0	0	0	0	0	0	0	0	0	0	0
2004	-1	0	0	0	0	0	-2	0	0	0	1	0	0
2005	1	1	0	0	0	0	0	0	0	0	0	0	0
2006	0	0	0	0	0	0	0	0	0	0	0	0	0
2007	0	0	0	0	0	0	0	0	0	0	0	0	0
2008	-3	0	0	1	0	1	1	0	-1	1	0	0	-6
2009	-1	0	0	0	0	0	0	-1	0	0	0	0	0
2010	-9	0	0	0	1	-1	0	0	0	0	0	0	-9
2011	3	0	0	0	0	0	0	0	0	0	2	1	0
2012	3	1	0	0	0	0	0	1	0	0	0	1	0
2013*	2	0	0	0	-2	5	0	0	0	-1	0	0	0
Summed Diffs:	-1081	-93	-127	-126	-112	-96	-105	-65	-57	-34	-15	-134	-117



Inventory of All Data Observations

VAFB 72393													
Year	Total Yearly Diffs:	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
1990	-12	-3	-4	1	-1	-1	0	-2	1	-3	3	-7	4
1991	-18	-4	0	-4	-3	-1	-4	-1	1	-2	0	0	0
1992	-13	1	-4	-2	0	-3	-6	-1	-1	4	7	1	-9
1993	11	5	-1	4	8	-5	0	3	-2	-3	2	1	-1
1994	-18	-1	-3	-1	-2	-2	0	-1	-3	-2	-1	-2	0
1995	-12	-1	0	0	-1	-5	-4	-1	1	-1	0	0	0
1996	-4	-4	0	0	0	0	0	0	0	0	0	0	0
1997	-1	0	0	0	-1	-4	-6	1	2	2	2	3	0
1998	-2	0	-3	0	0	1	0	0	0	0	0	0	0
1999	-16	0	-2	-1	-2	0	-2	0	-1	-1	0	-1	-6
2000	-11	0	0	-1	0	-1	0	-3	0	0	-1	-3	-2
2001	-13	0	0	0	0	-1	-1	-3	-3	-4	-1	1	-1
2002	-49	-5	-7	-4	-2	-11	-4	-5	0	-3	-2	-7	1
2003	-1	0	0	-1	0	0	0	0	0	0	0	0	0
2004	14	0	0	0	4	0	-1	2	0	0	2	3	4
2005	10	2	0	2	4	0	0	0	1	0	0	1	0
2006	-2	0	0	-1	-1	0	0	0	0	0	0	0	0
2007	-1	0	0	-1	0	0	0	0	0	0	0	0	0
2008	-28	-2	0	0	-1	0	-1	0	-1	0	0	0	-23
2009	-2	0	0	0	0	0	0	-2	0	0	0	0	0
2010	-21	0	0	0	0	0	0	0	0	0	-1	0	-20
2011	2	0	0	0	1	0	0	0	2	-2	2	-1	0
2012	-13	0	0	1	3	0	0	1	0	2	0	0	-20
2013*	4	0	0	0	-2	8	0	0	0	-2	0	0	0
Summed Diffs:	-196	-12	-24	-8	4	-25	-29	-12	-3	-15	12	-11	-73



Inventory of All Data Observations

- Despite the significant imbalances in inventory for some sites, the final tally for these 14 sites over this 23 year period ended up fairly close:

Total Analysis **ESRL** Inventory: 138,829 profiles

Total Analysis **IGRA** Inventory: 138,372 profiles

Methods of Quality Assurance

- Though the methodologies are slightly different, both ESRL and IGRA databases have been subjected to a robust array of quality assurance checks.
- The main take away is this...
 - The IGRA archive appears to be slightly more conservative, removing seemingly errant data when/if it fails various QA checks.
 - The ESRL archive seeks to retain as much data as possible by introducing corrective procedures when possible or reasonable if the data fails certain QA checks.

Future Work

- Perform a more in-depth inventory analysis on both sets of data that examines the number of available monthly profiles that are “unique” to (not shared by) each database.
- Select random concurrent profiles from each database and perform and in-depth quantitative and visual comparison.
- More closely examine the specific techniques that are used in each archive to retain, discard, or correct (ESRL) data.

Qualitative Comparison of IGRA and ESRL Radiosonde Archived Databases

Questions?

Qualitative Comparison of IGRA and ESRL Radiosonde Archived Databases

Backup

Availability of Data

- ESRL Online Data Access:
 - <http://www.esrl.noaa.gov/raobs/>
 - As of November 2013, only data from 1990 to the Present was accessible online*
 - All other data had to be ordered via email request for a CDROM.
 - Data records were only available for 13 out of the 14 upper air sites for which data was requested (Missing “WAK” / 91245).
- IGRA Online Data Access:
 - <http://www.ncdc.noaa.gov/oa/climate/igra/>
 - Entire archived period of record of data is accessible online.
 - Data records were available for all 14 upper air sites for which data was requested.

* (See next slide)

Availability of Data

(Recently posted update from the ESRL website):

January 2014

- Updated the archive with GTS data collected from NWS (IGRA archive) and ESRL/GSD data from 2010 thru 2013.
- Added about 250 new entries to the station list.
- Updated the inventory to include all observations from 2000 thru 2013.
- **Added North American observations for 1946 - 1993.** This data was originally produced on CDROM in 1992, and then updated. It does not contain data above 100 millibars pressure, and only observations from North America are available. An inventory will be available soon.

Availability and Accuracy of Documentation

- ESRL Web-based Documentation:

“In 2007, we completed a merge of GTS global data available through NCDC's IGRA project, with the observations we have collected at ESRL/GSD. The merged dataset contains significantly more observations than were available from either dataset”.

- As of the present, the above claim has been found to be invalid.
 - None of the “WAK” site data is available in ESRL’s “Real-Time Archive”.
 - There are still plenty of other gaps in the ESRL record for various sites for which the IGRA archive has data.

Availability and Accuracy of Documentation

- ESRL Web-based Documentation:
 - Provided online documentation of inventory for ESRL global data from 1994-2013 contains several errors
(Documentation Source: http://www.esrl.noaa.gov/raobs/inventory_1994-2013.lis)
 - None of the archived data from prior to 2000 is accounted for in the ESRL-provided inventory.
 - Data from 2000 through 2010 that exists in the ESRL archive is not always accounted for in the ESRL-provided inventory
 - (Ex: “Point Magu Naval Air Station, CA” (PTU / 72391)) *
 - Comparisons between the inventories of actual available data from online (1990-Present) and ESRL’s own inventory for various sites showed that ESRL’s documented inventory was slightly inflated for many of the years. *

* (See next slide)

Availability and Accuracy of Documentation

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Availability and Accuracy of Documentation

- ESRL Web-based Documentation:
 - Online documentation about the data structure and elements (header info and subsequent columns of data) is very well organized and easy to understand.
 - Detailed documentation of station history and related date ranges, down to the day (“YYYYMMDD” format), exist for each station, but there were several missing (“99999999”) values in place of the “end dates”, which devalued a great deal of that information.

Availability and Accuracy of Documentation

- [IGRA](#) Web-based Documentation:
 - Online documentation of observation inventory for IGRA lacks the fine-scale “monthly count” resolution that ESRL reports.
 - Online documentation about the data structure and elements (header info and subsequent columns of data) is very well organized and easy to understand.
 - Clear documentation of station history and related annual (“YYYY” format) range of data information exists for each station and has been found to be very accurate when compared to the yearly inventory analyses (to be shown later).

Availability and Accuracy of Documentation

- ESRL Electronic/Hard-copy Documentation:
 - Schwartz, B., and M. Govett, 1992: A hydrostatically consistent north American radiosonde data base at the Forecast Systems Laboratory, 1946-present. Boulder, Colo.: U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration, Environmental Research Laboratories, Forecast Systems Laboratory.
- IGRA Electronic/Hard-copy Documentation:
 - Durre, Imke, Russell S. Vose, and David B. Wuertz, 2006: Overview of the Integrated Global Radiosonde Archive. *J. Climate*. **19**, 53-68.
 - Durre, Imke, Russell S. Vose, and David B. Wuertz, 2008: Robust Automated Quality Assurance of Radiosonde Temperatures. *J. Appl. Meteor. Climatol.*, **47**, 2081–2095.
 - Durre, Imke and Xungang Yin, 2008: Enhanced upper-air data: An IGRA-derived product. To be submitted to the Bulletin of the American Meteorological Society. <---(Was unable to locate this resource)

Data Format and Content

- ESRL File Formats:
 - 1) FSL Format (new) – ASCII text
 - 2) FSL Format (original) – ASCII text
 - 3) FAA604 Format (WMO/GTS; “TTAA, TTBB, etc...”) – ASCII text
 - 4) NetCDF – Binary
 - 5) Skew-T Plot Image
- IGRA File Formats:
 - 1) Columnar – ASCII text

Data Format and Content

- Data Sampling at High Altitudes:
 - IGRA observations INCLUDE wind data above 100mb
 - ESRL observations DO NOT INCLUDE wind data above 100mb
- Conventions for Reporting Humidity:
 - IGRA reports dew point depression
 - ESRL reports actual dew point values
- Location of Additional Wind Level Data:
 - IGRA additional wind level data is put at the END of an observation record. (*No Pressure heights provided / Only geopotential height*)
 - ESRL additional wind level data is included IN BETWEEN the mandatory and significant level info, in order of ascending heights. (*Pressure heights –and– geopotential heights provided*)

Data Format and Content

- Units for Reporting Wind Speed:
 - IGRA provides wind speed units in tenths of “m/s”
 - ESRL optionally provides winds peed in units of whole number “knots” or in tenths of “m/s”
- Data Below Ground:
 - IGRA does NOT provide any data for pressure levels that are below the surface
 - ESRL provides geopotential height for mandatory levels, even if they are BELOW the surface
- Missing/Removed Values:
 - IGRA missing values = “-9999” (Except for launch release time in header = “9999”)
IGRA QC removed values = “-8888” (IGRA)
 - ESRL missing values = “99999”






Data Format and Content

- Valid Times:
 - IGRA and ESRL both contain “Report” and “Launch Release” times
 - Report times are sometimes different by one hour for concurrent obs
- Surface Observations:
 - IGRA and ESRL both provide surface observations
 - Surface level heights may not always match for concurrent obs, but the other data (including pressure) always seems to match
- Included Data Level Reports:
 - IGRA and ESRL both contain mandatory, significant, and additional wind level data
- Observational Differences:
 - Sometimes, the data values for concurrent ESRL/IGRA observations are different by up to one full unit.

Data Format and Content

- ESRL File Formats:
 - Available in five different formats
 - ASCII text (3)
 - Binary
 - Image
- IGRA File Formats:
 - Available in one format
 - ASCII text

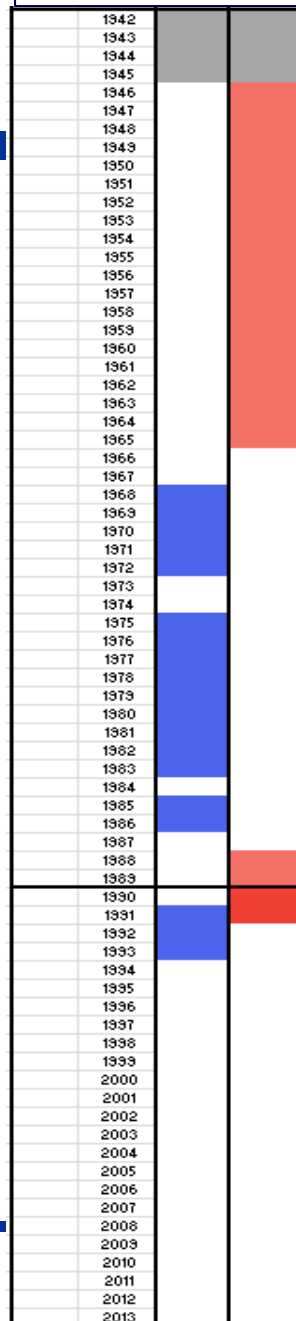
Legend

-  IGRA
-  ESRL
(1990-Present)
-  ESRL
(Pre-1990)
-  No Data from
Either Source
-  No Data for
Given Source

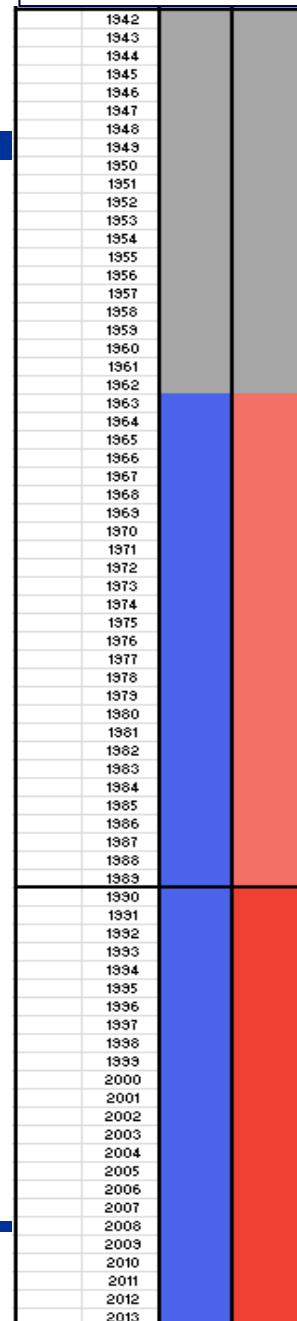
Left Column:
IGRA Data

Right Column:
ESRL Data

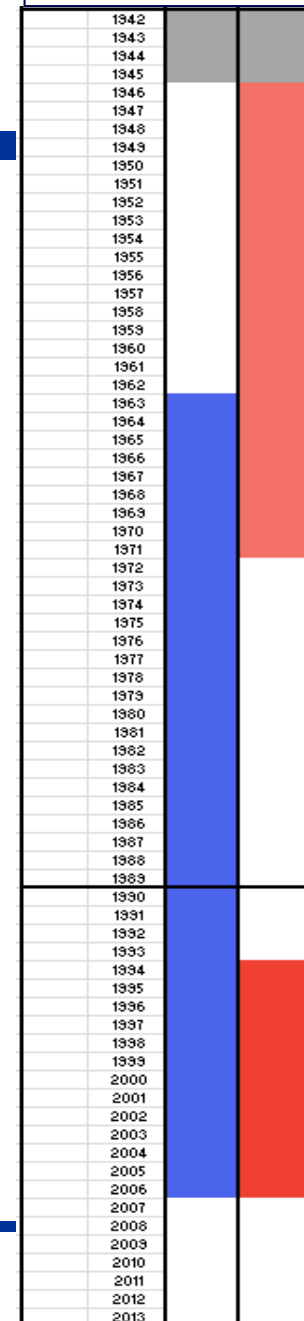
WSMR








WFF



THU



Legend

-  IGRA
-  ESRL
(1990-Present)
-  ESRL
(Pre-1990)
-  No Data from
Either Source
-  No Data for
Given Source

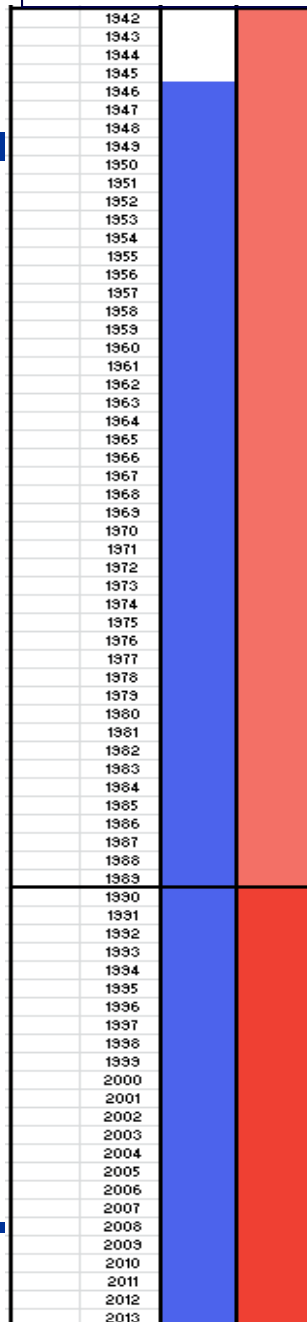
Left Column:

IGRA Data

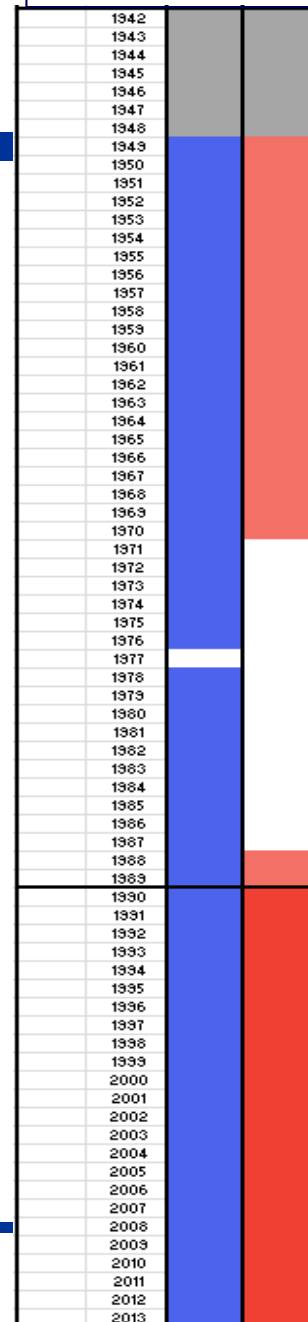
Right Column:

ESRL Data

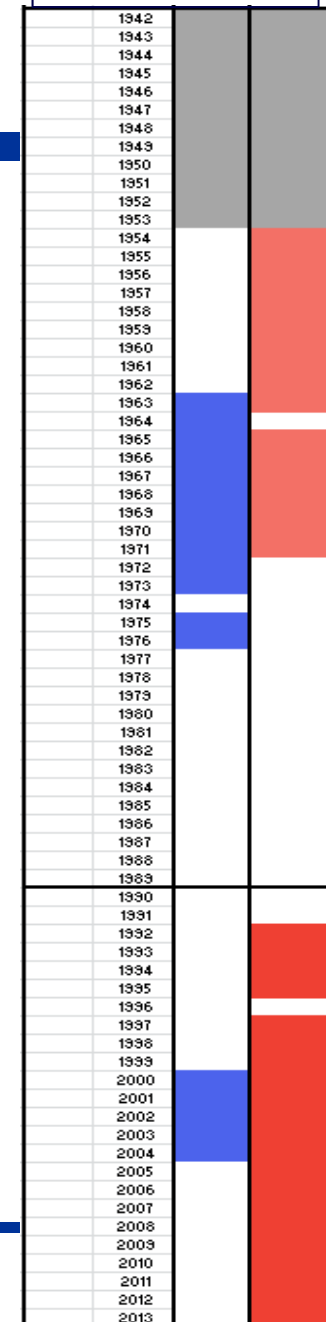
KOD



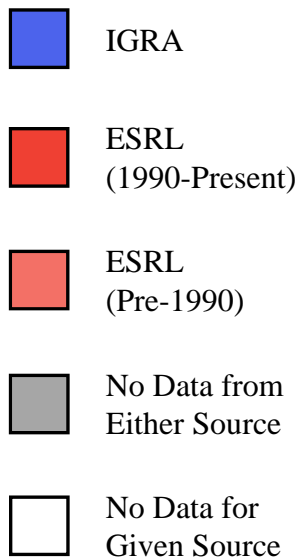
EGL



YSD



Legend



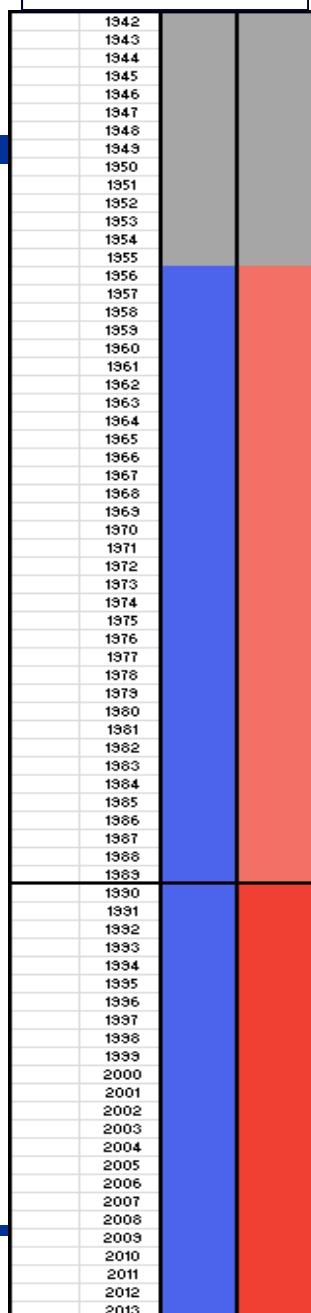
Left Column:

IGRA Data

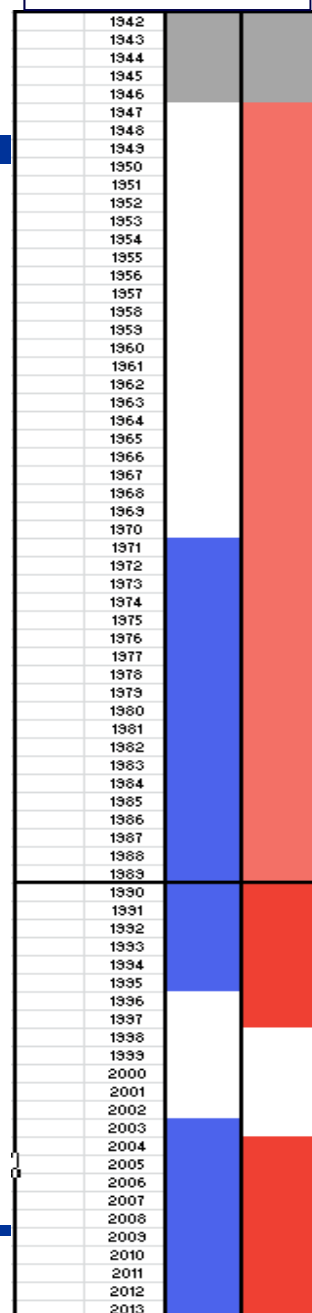
Right Column:

ESRL Data

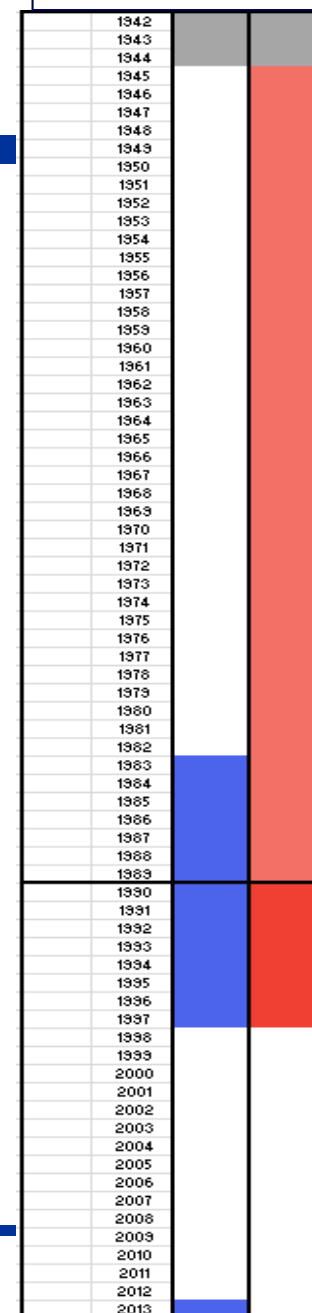
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

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Legend

-  IGRA
-  ESRL (1990-Present)
-  ESRL (Pre-1990)
-  No Data from Either Source
-  No Data for Given Source

Left Column:
IGRA Data

Right Column:
ESRL Data

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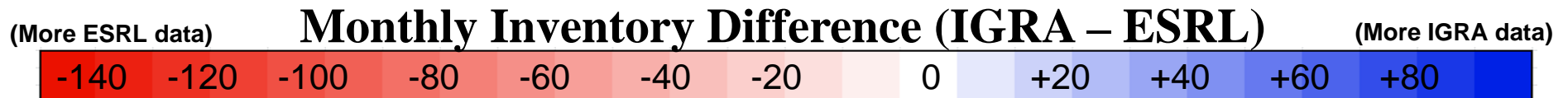
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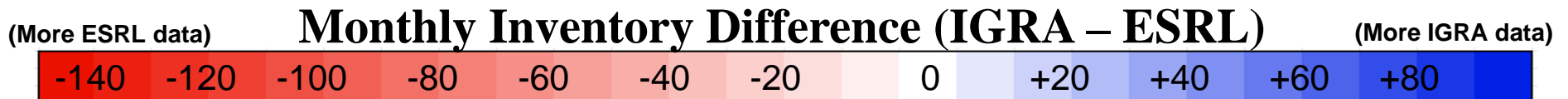
Inventory of All Data Observations

WSMR 72269													
Year	Total Yearly Diffs:	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
1990	-1	0	0	0	0	0	0	0	0	0	-1	0	0
1991	31	0	0	0	-7	-12	-4	14	3	9	0	12	16
1992	131	0	20	18	3	11	20	4	17	18	0	12	8
1993	72	3	16	14	3	13	11	1	9	2	0	0	0
1994	0	0	0	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0	0	0	0
2006	0	0	0	0	0	0	0	0	0	0	0	0	0
2007	0	0	0	0	0	0	0	0	0	0	0	0	0
2008	0	0	0	0	0	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0	0	0	0	0	0
2011	0	0	0	0	0	0	0	0	0	0	0	0	0
2012	0	0	0	0	0	0	0	0	0	0	0	0	0
2013*	0	0	0	0	0	0	0	0	0	0	0	0	0
Summed Diffs:	233	3	36	32	-1	12	27	19	29	29	-1	24	24



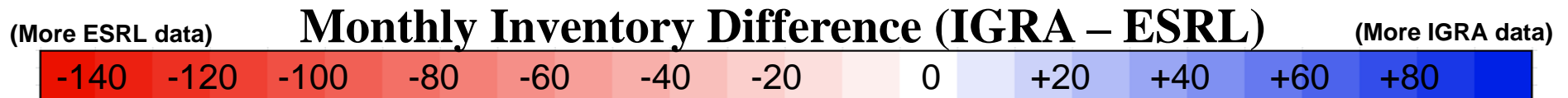
Inventory of All Data Observations

WFF 72402													
Year	Total Yearly Diffs:	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
1990	-208	0	0	-2	0	0	0	0	0	-52	-56	-53	-45
1991	14	2	0	2	2	0	0	6	1	1	0	0	0
1992	45	4	8	4	4	2	2	1	4	12	2	0	2
1993	17	9	0	0	1	3	1	2	0	0	0	1	0
1994	9	0	1	0	0	0	0	3	2	1	1	1	0
1995	2	0	0	0	0	0	1	0	0	0	0	0	1
1996	0	0	0	0	0	-1	0	0	0	0	1	0	0
1997	17	0	-1	0	0	0	-2	0	0	0	4	10	6
1998	-15	0	-6	-2	-4	-1	1	-2	0	1	-1	0	-1
1999	-2	-1	0	1	-2	1	1	-1	0	0	-4	1	2
2000	-1	-1	1	-2	-1	0	2	0	-1	1	-1	1	0
2001	-6	0	2	-1	1	-3	1	-3	-1	1	-2	1	-2
2002	-37	-3	-4	-3	-1	-8	-3	-2	0	-5	-2	-6	0
2003	-2	0	0	-1	0	0	0	0	0	-1	0	0	0
2004	7	0	0	0	2	0	-1	3	1	0	2	0	0
2005	2	0	0	0	2	0	0	0	0	0	0	0	0
2006	-1	-1	0	0	0	0	0	0	0	0	0	0	0
2007	-2	0	0	0	0	0	-2	0	0	0	0	0	0
2008	-44	-2	0	0	-2	0	-2	0	-2	0	0	0	-36
2009	-1	0	0	0	0	0	0	-1	0	0	0	0	0
2010	-40	-2	0	0	0	0	0	0	0	1	-2	0	-37
2011	3	0	0	0	1	0	0	-1	2	0	2	-1	0
2012	-28	1	0	-1	2	0	0	2	0	4	0	0	-36
2013*	8	0	-1	0	0	16	-1	-2	0	-4	0	0	0
Summed Diffs:	-263	6	0	-5	5	9	-2	5	6	-40	-56	-45	-146



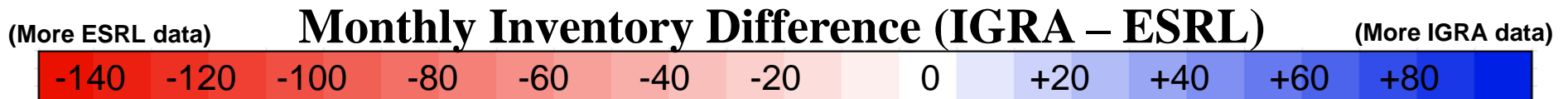
Inventory of All Data Observations

THU 4202													
Year	Total Yearly Diffs:	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
1990	621	58	47	50	53	49	51	48	56	59	56	55	39
1991	438	0	0	3	3	57	47	60	53	55	56	55	49
1992	688	62	53	62	58	56	57	56	58	57	56	55	58
1993	372	60	52	59	56	56	35	0	0	0	0	1	53
1994	1	0	0	0	0	0	2	0	-1	0	1	0	-1
1995	0	1	0	0	0	0	0	-1	1	0	0	0	-1
1996	0	1	0	0	-1	1	0	0	0	0	0	0	-1
1997	0	1	-1	1	0	0	0	0	-1	1	0	0	-1
1998	0	1	-1	0	0	0	0	1	0	0	-1	0	0
1999	-154	0	0	-2	-1	1	0	-2	0	0	-34	-59	-57
2000	-21	-1	0	-6	1	0	0	0	1	-3	-3	-8	-2
2001	-30	0	0	0	-8	-3	-1	-2	-4	-4	-1	-4	-3
2002	-19	0	-4	-3	-2	-6	-3	-1	0	0	-1	1	0
2003	0	0	0	-1	0	0	0	0	1	-1	0	1	0
2004	0	0	0	0	-1	0	-1	0	-1	1	2	0	0
2005	4	-2	1	0	5	-1	0	1	0	0	0	0	0
2006	-3	-1	0	0	0	0	0	-1	0	0	-1	0	0
2007	0	0	0	0	0	0	0	0	0	0	0	0	0
2008	0	0	0	0	0	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0	0	0	0	0	0
2011	0	0	0	0	0	0	0	0	0	0	0	0	0
2012	0	0	0	0	0	0	0	0	0	0	0	0	0
2013*	0	0	0	0	0	0	0	0	0	0	0	0	0
Summed Diffs:	1897	180	147	163	163	210	187	159	163	165	130	97	133



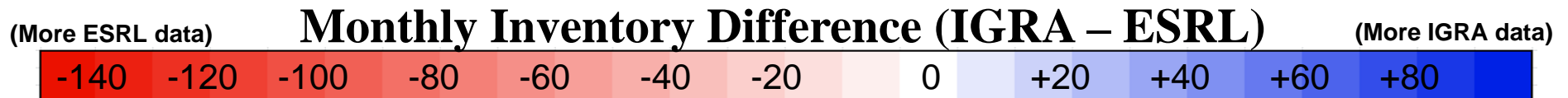
Inventory of All Data Observations

KOD 70350													
Year	Total Yearly Diffs:	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
1990	-40	0	0	0	0	0	0	0	1	1	0	-3	-39
1991	18	3	1	0	0	2	3	-1	2	1	2	4	1
1992	26	3	2	0	1	3	1	2	4	7	3	-1	1
1993	22	1	4	5	1	2	0	-3	1	5	4	2	0
1994	8	0	0	0	2	1	0	1	0	1	0	2	1
1995	-3	1	0	0	0	3	0	-9	1	0	0	1	0
1996	-3	1	-3	0	-2	0	0	0	0	0	0	1	0
1997	3	0	0	0	0	1	1	-1	1	0	0	1	0
1998	-48	-6	-13	-9	-5	-12	-2	0	0	-1	0	1	-1
1999	7	1	0	0	-1	1	1	1	2	1	0	1	0
2000	1	1	0	0	-1	1	0	-1	1	0	1	0	-1
2001	3	1	0	0	1	0	0	1	1	0	0	0	-1
2002	-34	-3	-4	-4	-1	-6	-2	-2	0	-4	-2	-6	0
2003	0	0	0	-1	0	1	0	0	0	0	0	0	0
2004	-2	0	0	0	0	0	-2	0	0	0	0	0	0
2005	2	-1	0	0	2	0	0	0	0	0	0	1	0
2006	-2	-1	0	0	0	0	0	-1	0	0	0	0	0
2007	1	1	0	0	0	0	0	0	0	0	0	0	0
2008	-44	-2	0	0	-2	0	-2	0	-2	0	0	0	-36
2009	0	0	0	0	0	0	1	-1	0	0	0	0	0
2010	-36	0	0	0	0	0	0	0	0	0	0	0	-36
2011	8	0	0	0	1	0	0	0	4	2	2	-1	0
2012	-27	2	0	0	2	0	0	2	0	3	0	0	-36
2013*	13	0	0	0	0	16	0	0	0	-3	0	0	0
Summed Diffs:	-127	2	-13	-9	-2	13	-1	-12	16	13	10	3	-147



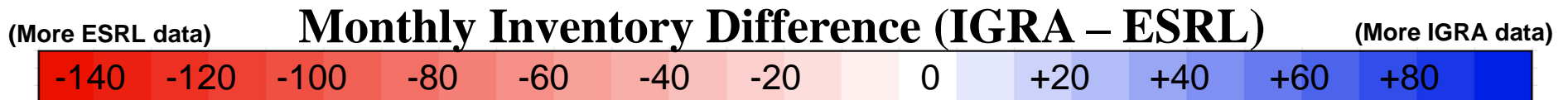
Inventory of All Data Observations

EGL 72221													
Year	Total Yearly Diffs:	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
1990	1	-3	-5	-2	3	-2	-2	-1	3	4	1	1	4
1991	-21	-3	-1	-8	1	-5	-4	-1	-2	1	0	0	1
1992	57	1	2	4	2	2	2	2	6	11	9	6	10
1993	-66	-13	-13	-15	0	1	0	3	7	-16	-6	-5	-9
1994	-45	-8	-12	-21	0	-2	0	0	-1	-1	0	0	0
1995	-8	-1	-1	-1	-2	0	-1	0	-1	0	-2	1	0
1996	1	0	0	0	0	0	1	0	0	0	0	0	0
1997	-5	0	-1	0	1	0	-3	0	0	0	-1	0	-1
1998	-1	0	0	0	0	0	0	0	0	0	0	-1	0
1999	-3	0	0	0	0	0	0	0	0	0	0	-1	-2
2000	-5	0	0	0	0	-1	0	0	-1	-1	-1	0	-1
2001	-4	0	0	0	0	-1	0	0	-1	-2	0	0	0
2002	-64	-5	-7	-8	-4	-10	-8	-3	-1	-10	-2	-6	0
2003	-2	0	0	-2	0	0	0	0	0	0	0	0	0
2004	-2	0	0	0	0	0	-2	0	0	0	0	0	0
2005	-1	-1	0	0	1	-1	0	0	0	0	0	0	0
2006	1	0	0	0	0	0	0	0	0	0	0	1	0
2007	0	0	0	0	0	1	-1	1	-1	0	0	0	0
2008	-12	0	0	0	0	0	0	0	0	0	0	0	-12
2009	4	0	0	0	0	0	0	0	0	4	0	0	0
2010	-5	0	0	0	0	0	0	0	0	1	-1	0	-5
2011	0	0	0	0	0	0	0	0	0	0	0	0	0
2012	0	1	0	0	0	0	0	0	0	0	0	0	-1
2013*	0	0	0	0	0	0	0	0	0	0	0	0	0
Summed Diffs:	-180	-32	-38	-53	2	-18	-18	1	8	-9	-3	-4	-16



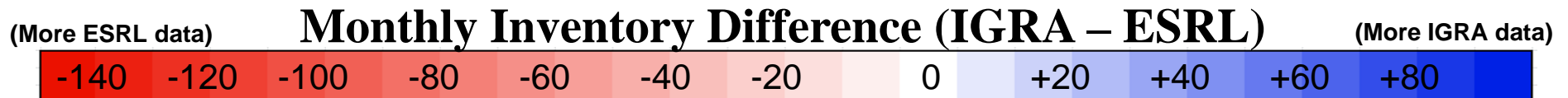
Inventory of All Data Observations

YSD 72280													
Year	Total Yearly Diffs:	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
1990	0	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	0	0
1992	-115	0	0	0	0	-12	-21	-20	-20	-14	-14	-13	-1
1993	-156	-16	-19	-16	-14	-16	-17	-20	-7	-10	-16	-5	0
1994	-129	-14	-18	-20	-13	-8	-2	-8	-11	-7	-5	-13	-10
1995	-56	-11	-10	-14	-11	-3	0	-2	-2	-3	0	0	0
1996	0	0	0	0	0	0	0	0	0	0	0	0	0
1997	-13	0	0	0	0	0	-1	-12	0	0	0	0	0
1998	-203	-12	-15	-19	-9	-12	-22	-23	-20	-18	-20	-16	-17
1999	-230	-15	-15	-22	-17	-17	-18	-22	-25	-18	-19	-21	-21
2000	-259	-18	-25	-26	-18	-19	-22	-21	-29	-16	-24	-20	-21
2001	-245	-14	-14	-19	-25	-24	-20	-34	-21	-16	-20	-18	-20
2002	-260	-20	-17	-19	-24	-20	-24	-28	-21	-27	-21	-18	-21
2003	-273	-22	-23	-23	-19	-21	-20	-25	-26	-30	-25	-17	-22
2004	-306	-18	-27	-25	-20	-19	-21	-47	-49	-22	-15	-25	-18
2005	-284	-25	-19	-28	-16	-21	-33	-26	-30	-25	-24	-17	-20
2006	-743	-18	-18	-40	-38	-70	-69	-52	-111	-83	-101	-77	-66
2007	-964	-87	-42	-25	-57	-84	-83	-75	-117	-114	-99	-100	-81
2008	-1189	-123	-107	-119	-104	-101	-118	-105	-109	-83	-52	-87	-81
2009	-1034	-104	-114	-112	-114	-139	-134	-107	-43	-57	-47	-37	-26
2010	-298	-31	-23	-23	-22	-29	-21	-45	-27	-20	-22	-21	-14
2011	-1008	-20	-14	-21	-82	-138	-133	-78	-94	-114	-99	-108	-107
2012	-1419	-125	-143	-119	-117	-99	-49	-15	-163	-177	-85	-208	-119
2013*	-728	-82	-90	-100	-54	-49	-75	-84	-114	-60	-20	0	0
Summed Diffs:	-9912	-775	-753	-790	-774	-901	-903	-849	-1039	-914	-728	-821	-665



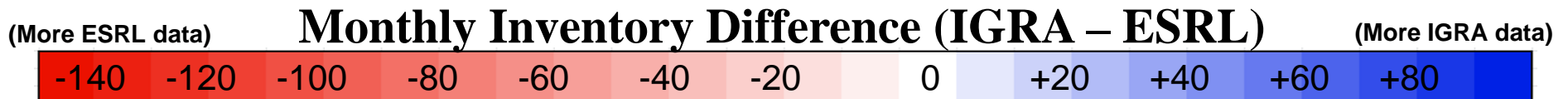
Inventory of All Data Observations

DUG 72572													
Year	Total Yearly Diffs:	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
1990	-51	-1	0	0	0	0	0	0	-2	0	0	0	-48
1991	5	0	0	0	0	-1	0	1	0	1	1	2	1
1992	16	1	1	2	3	0	2	2	3	2	1	0	-1
1993	9	0	0	0	1	0	2	2	2	0	0	1	1
1994	3	1	0	0	-1	0	0	1	-1	2	0	1	0
1995	-12	0	1	0	0	0	-1	-11	1	0	0	-1	-1
1996	-1	0	1	0	-1	0	1	0	0	0	-2	0	0
1997	1	0	0	0	0	0	0	0	0	0	1	0	0
1998	0	0	0	-3	0	1	0	0	0	0	1	1	0
1999	3	0	0	1	0	0	0	0	0	0	1	0	1
2000	0	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	1	0	0	0	0	-1	1	0	0	-1
2002	-37	-3	-4	-5	-1	-6	-3	-3	0	-4	-2	-6	0
2003	-2	0	-1	-1	0	0	0	0	0	0	0	0	0
2004	6	0	0	0	2	0	-1	2	0	0	2	0	1
2005	1	-1	0	0	2	0	0	0	0	0	0	0	0
2006	-2	-2	0	0	0	0	0	0	0	0	0	0	0
2007	0	0	0	0	0	0	0	0	0	0	0	0	0
2008	-42	-1	0	0	-1	0	-2	0	-2	0	0	0	-36
2009	-3	0	0	0	0	0	-2	-1	0	0	0	0	0
2010	-36	0	0	0	0	0	0	0	0	0	0	0	-36
2011	3	0	0	0	0	0	0	0	2	0	2	-1	0
2012	-27	1	0	0	2	0	0	2	0	4	0	0	-36
2013*	12	0	0	0	0	16	0	0	0	-4	0	0	0
Summed Diffs:	-154	-5	-2	-5	6	10	-4	-5	2	2	5	-3	-155



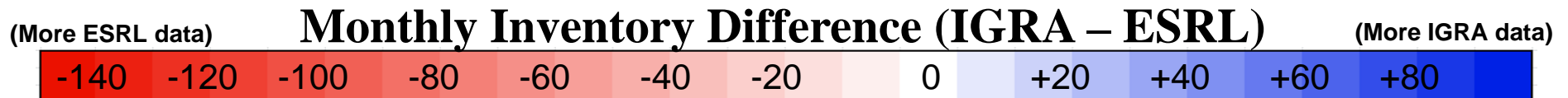
Inventory of All Data Observations

PTU 72391													
Year	Total Yearly Diffs:	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
1990	52	-8	-7	2	14	4	5	7	8	3	5	16	3
1991	134	12	14	18	11	10	5	11	17	12	11	8	5
1992	122	11	8	6	13	10	11	7	15	17	11	8	5
1993	-182	-18	-20	-12	-8	14	-24	-18	-23	-11	-16	-21	-25
1994	-125	-3	-16	-21	-2	-18	-14	-5	1	-14	-8	-8	-17
1995	-165	-2	-9	-7	-6	-8	-12	0	0	0	-52	-44	-25
1996	-319	-38	-45	-40	-31	-27	-22	-25	-25	-20	-21	-18	-7
1997	-224	-23	-14	-22	-19	-21	-17	-15	-22	-18	-23	-16	-14
1998	0	0	0	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	0
2003	27	0	0	0	0	0	0	0	7	2	8	3	7
2004	0	0	0	0	0	0	0	0	0	0	0	0	0
2005	10	0	0	1	5	1	0	0	3	0	0	0	0
2006	0	0	0	0	0	0	0	0	0	0	0	0	0
2007	0	0	0	0	0	0	0	0	0	0	0	0	0
2008	-3	0	0	0	0	0	0	0	0	0	0	0	-3
2009	1	0	0	0	0	0	0	0	0	1	0	0	0
2010	-4	0	0	0	0	0	0	0	0	0	0	0	-4
2011	126	13	12	9	7	5	14	12	30	9	4	8	3
2012	92	1	6	6	11	3	4	17	17	9	9	7	2
2013*	71	0	1	6	11	10	1	9	11	10	12	0	0
Summed Diffs:	-387	-55	-70	-54	6	-17	-49	0	39	0	-60	-57	-70



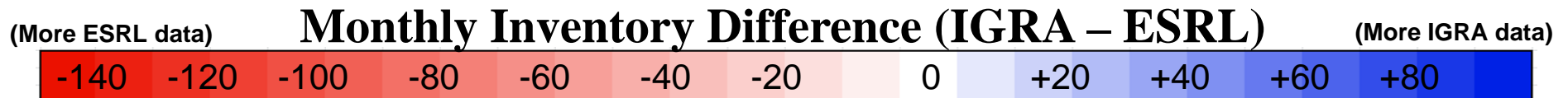
Inventory of All Data Observations

CHL 74612													
Year	Total Yearly Diffs:	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
1990	17	0	0	1	0	1	1	1	3	3	1	1	5
1991	2	1	1	0	0	0	0	0	0	-1	0	0	1
1992	23	1	3	0	4	6	0	2	1	2	3	0	1
1993	-598	-46	-42	-50	2	-44	-57	-63	-57	-65	-56	-57	-63
1994	-783	-71	-78	-85	-71	-89	-61	-60	-87	-58	-38	-45	-40
1995	-485	-35	-43	-62	-47	-41	-45	-47	-56	-46	-57	-6	0
1996	-389	-34	-39	-36	-46	-49	-37	-31	-38	-49	-19	-5	-6
1997	-343	-16	-14	-19	-10	-24	-45	-46	-57	-45	-30	-19	-18
1998	0	0	0	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0	0	0	0
2006	0	0	0	0	0	0	0	0	0	0	0	0	0
2007	0	0	0	0	0	0	0	0	0	0	0	0	0
2008	0	0	0	0	0	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0	0	0	0	0	0
2011	0	0	0	0	0	0	0	0	0	0	0	0	0
2012	0	0	0	0	0	0	0	0	0	0	0	0	0
2013*	25	0	0	0	4	8	3	2	7	0	1	0	0
Summed Diffs:	-2531	-200	-212	-251	-164	-232	-241	-242	-284	-259	-195	-131	-120



Inventory of All Data Observations

WAK 91245													
Year	Total Yearly Diffs:	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
1990	732	62	55	64	60	61	59	61	61	64	62	61	62
1991	740	63	60	62	60	61	70	64	65	57	56	60	62
1992	727	62	56	64	58	59	56	56	57	59	77	61	62
1993	763	92	56	62	61	63	64	55	66	60	62	60	62
1994	739	63	57	58	67	61	60	62	61	60	64	63	63
1995	739	63	56	63	60	61	61	64	59	65	64	60	63
1996	747	59	58	63	61	66	66	61	63	66	62	60	62
1997	261	62	54	59	60	26	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0	0	0	0
2006	0	0	0	0	0	0	0	0	0	0	0	0	0
2007	0	0	0	0	0	0	0	0	0	0	0	0	0
2008	0	0	0	0	0	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0	0	0	0	0	0
2011	0	0	0	0	0	0	0	0	0	0	0	0	0
2012	0	0	0	0	0	0	0	0	0	0	0	0	0
2013*	0	0	0	0	0	0	0	0	0	0	0	0	0
Summed Diffs:	5448	526	452	495	487	458	436	423	432	431	447	425	436



Inventory of All Data Observations

KMR 91366													
Year	Total Yearly Diffs:	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
1990	596	55	34	47	56	56	52	56	54	63	60	35	28
1991	687	43	48	61	54	61	60	61	53	61	65	60	60
1992	771	78	63	72	57	65	57	61	58	56	75	68	61
1993	734	60	59	62	57	58	61	64	66	57	66	56	68
1994	709	57	55	56	56	60	60	62	61	59	63	55	65
1995	696	62	55	61	68	57	55	55	59	57	57	51	59
1996	551	52	52	59	56	57	57	53	57	56	52	0	0
1997	1	0	1	-1	0	0	0	0	0	0	0	0	1
1998	1	0	0	0	1	0	0	0	0	0	0	0	0
1999	-4	-1	-1	0	0	0	0	0	0	-2	1	0	-1
2000	-2	0	0	0	0	-2	0	0	0	0	0	0	0
2001	-4	0	0	-1	0	0	-1	-1	-1	0	0	0	0
2002	-64	-5	-6	-7	-4	-18	-5	-5	-1	-6	-2	-5	0
2003	-1	1	0	-1	0	0	0	0	-1	0	0	0	0
2004	-1	0	0	0	0	0	-1	0	0	0	0	0	0
2005	7	-1	2	1	3	0	0	0	0	0	1	1	0
2006	-1	0	-1	0	0	0	0	0	0	0	0	0	0
2007	16	0	0	0	0	0	0	15	0	0	1	-1	1
2008	-30	0	0	1	0	0	1	-1	0	0	1	-2	-30
2009	12	0	0	0	0	0	0	0	0	12	0	0	0
2010	-24	0	0	0	0	0	0	0	0	0	0	0	-24
2011	589	42	54	53	58	62	58	61	62	57	61	19	2
2012	128	3	5	4	3	4	4	4	5	4	52	28	12
2013*	268	27	26	30	28	30	16	33	29	23	26	0	0
Summed Diffs:	5635	473	446	497	493	490	474	518	501	497	579	365	302

